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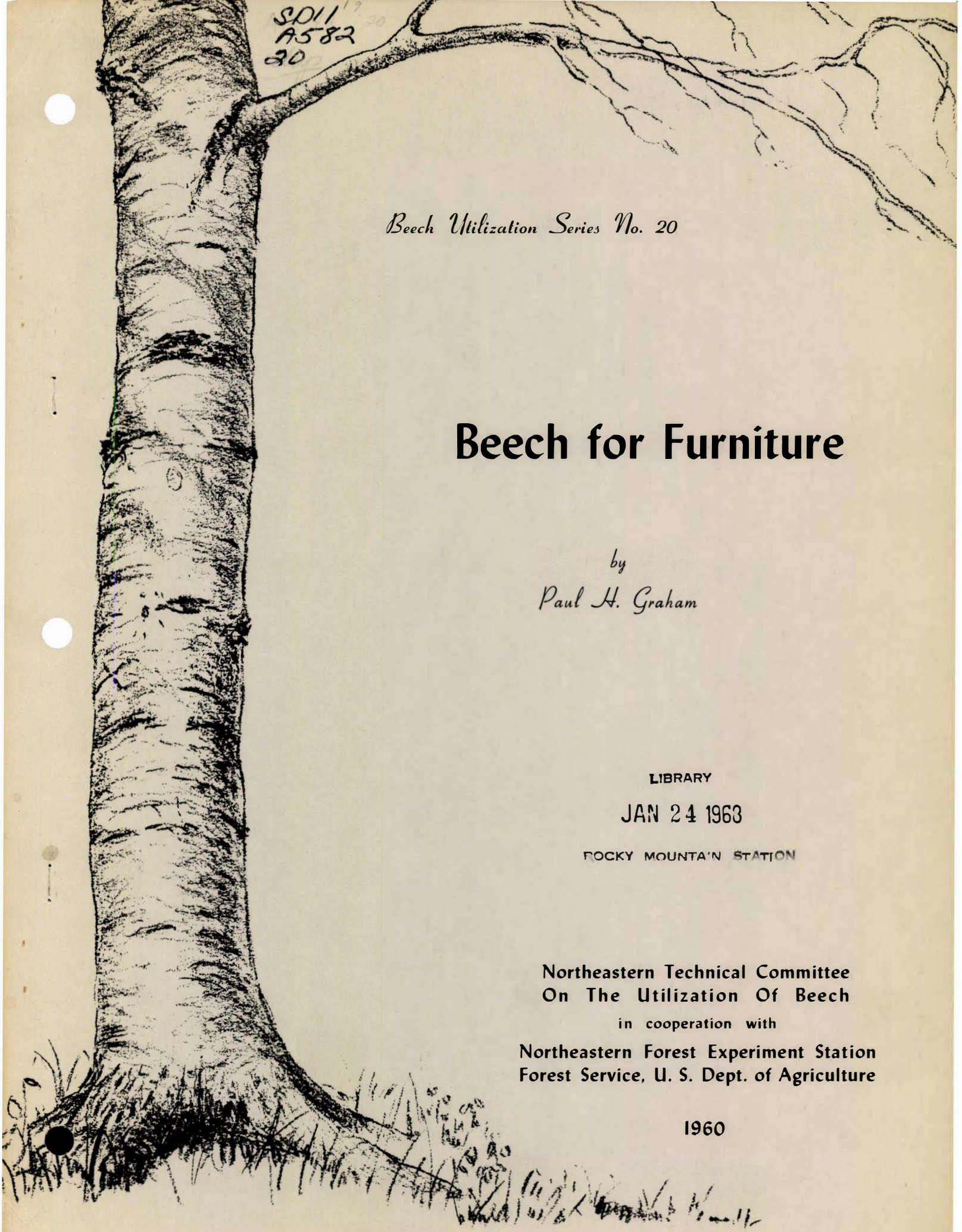

Beech Utilization Series No. 20

Beech for Furniture

by

Paul H. Graham

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ROCKY MOUNTAIN STATION

Northeastern Technical Committee
On The Utilization Of Beech

in cooperation with

Northeastern Forest Experiment Station
Forest Service, U. S. Dept. of Agriculture

1960

FOREWORD

The wood of the American beech tree (Fagus grandifolia Ehrh.) is well suited for a large number of uses, and it is rather widely used by manufacturers. Yet the amount used is not in proportion to the amount that grows in our northeastern forests. The utilization of beech--both in the woods and in the factory--has been recognized as a problem.

One reason for this is in the nature of the wood: it has a reputation for being difficult to season. Another is that many of the beech trees in our forests are of poor quality. And there are some plain prejudices against beech.

Research is finding ways to utilize beech as efficiently as any of the other comparable hardwoods can be handled. Considerable information about beech has been gathered. Yet most of this information is available only in fragmentary form in scattered technical reports. Some of it has never been published.

To study the problems of putting beech to the uses it deserves, and to promote the better management of the forests in which it grows, a Northeastern Technical Committee on the Utilization of Beech was organized in 1949. This committee, which includes representatives of Federal and State forestry agencies, universities, and state experiment stations, decided to assemble and publish the available information about the utilization of American beech.

As its part of this cooperative project, the Northeastern Forest Experiment Station has undertaken to edit, publish, and distribute the series of reports that will contain this information.

The subjects of these reports will be as follows:

* Physical and mechanical properties of American beech.

(CONTINUED ON INSIDE OF BACK COVER)

Beech for Furniture

by

Paul H. Graham

Clinic of Wood
Newfane, Vermont

IN THE furniture industry, American beech *(Fagus grandifolia)* has somewhat the status of a ghostwriter: it does much of the work but gets very little of the credit. One often sees a piece of furniture advertised as birch or maple, but which on close inspection proves to be beech. You may even see a piece advertised as solid walnut, in which the wood lurking below the walnut finish turns out to be beech.

It is a silly old prejudice against beech (partly because at one time it was considered hard to season) that forces this fine wood to masquerade under the identity of other hardwoods such as birch and maple, which it closely resembles.

Yet beech possesses certain properties and combinations of properties that suit the wood very well for use in furniture. There are few native hardwoods that are as hard and strong as beech; and, despite opinions to the contrary, beech is not too difficult to season or work. Undesirable qualities that have been attributed to beech are not due to any lack in the qualities of the wood; rather they can usually be traced to failure to exercise good judgment and proper control in seasoning and working.

Figure 1.--*Puzzle: find the beech in this typical dining-room furniture group, which is advertised as 'solid maple'. Answer: the bent top combs of the Windsor chairs and the curved slats of the ladder-back chairs are made of beech. So are drawer parts and interior frame and reinforcement members of the case goods. Beech dowels are used in the table and case assemblies.*

USES OF BEECH

The current restricted use of beech for furniture is due primarily to lack of appreciation of its excellent physical properties and insufficient knowledge of seasoning and working methods rather than any pronounced deficiency of the wood.

A commercial survey of native hardwoods used in the manufacture of wood furniture in the Northeast (based on volume used) rated sugar maple first, yellow birch second, beech third, and black cherry fourth. In this listing, however, beech did not receive full credit as it was frequently used for furniture component parts under the identity of birch and maple (fig. 1). Nor did beech receive proper

credit for its use in veneered furniture constructions where it was used for interior reinforcement to strengthen the base frame and to provide the foundation for the more expensive veneer woods.

Beech has long been favored as furniture wood in the manufacture of juvenile furniture (fig. 2) and breakfast and dinette sets in enamel and colored lacquer finishes. It has also been used for exterior parts of other types of furniture where a fancy grain figure was not required and the wood could be obscured by stain. Various attractive and unique novelty finishes have also been used to compensate for the lack of distinctive grain figure in beech.

Beech has been used extensively in the manufacture of chairs, and here too its identity has also been obscured. When bentwood dining chairs with full bent backs and circular seat frames were in favor, beech was the most popular native wood used in their construction (fig. 3). Beech is still favored for bentwood parts (fig. 4). Its hardness also makes it preferred for rockers and platform-rocker bearing blocks (fig. 5).

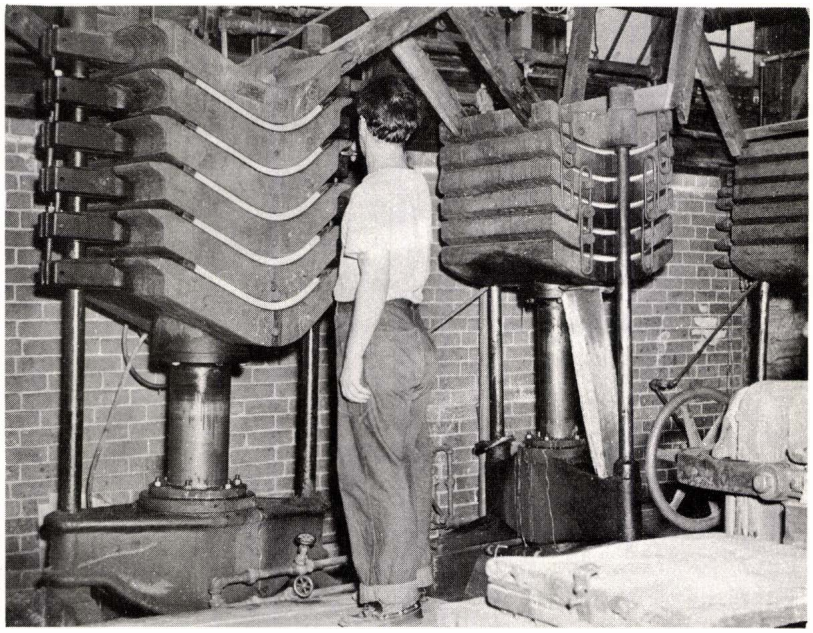

Figure 2.--*Beech parts for juvenile furniture being bent in a hot press. Beech has long been favored as furniture wood in the manufacture of juvenile furniture, and in breakfast and dinette furniture, usually with a colored lacquer finish.*

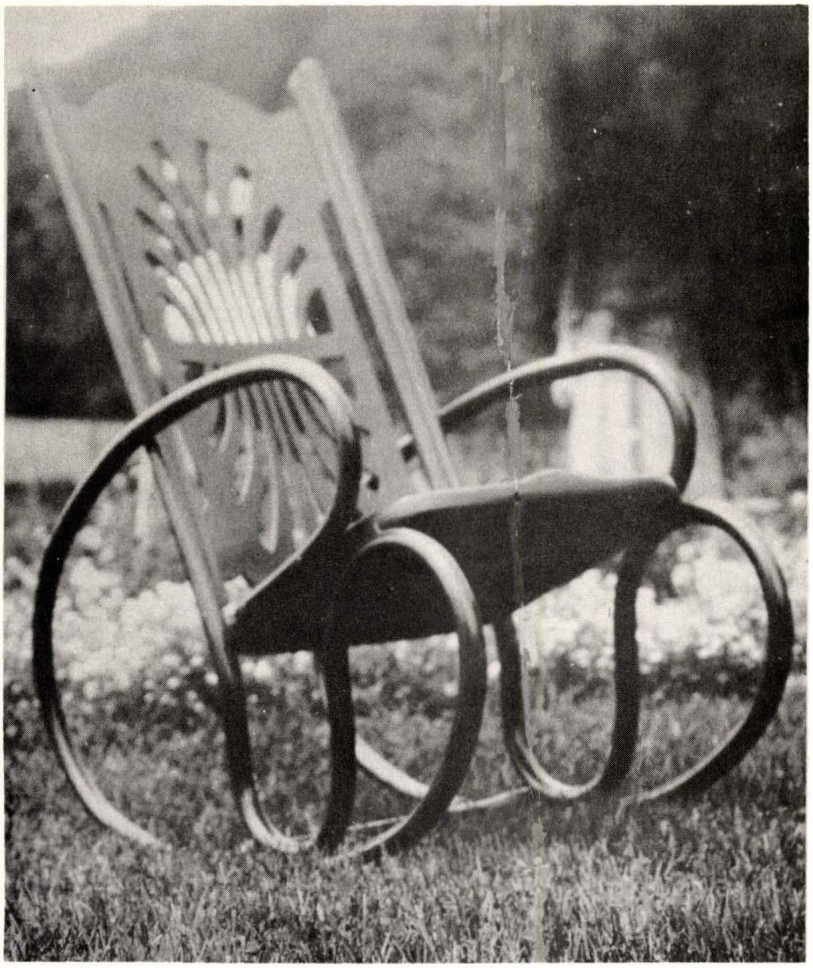

Figure 3.--*This chair, made in 1885, demonstrates the superior steam-bending qualities of beech. One continuous piece is used to form backpost, arm, and rocker.*

Considerable beech is used in the construction of upholstery frames, even for exposed wood components such as back posts, frame rails, stretchers, slats, wings, arms, and arm standards or stumps.

Beech is used extensively in the furniture trade for joinery and bracery members such as dowels, glue blocks, corner blocks, and supporting and sliding strips. Many interior case frames are made entirely of beech for better stiffness, strength, and rigidity.

Though beech is not considered to be a true veneer wood, a good yield of face veneer is obtained from selected beech logs. This face veneer is quite suitable for making matched faces on fine furniture. Beech veneer and plywood have been used very effectively in many furniture lines, usually in interior parts such as drawer bottoms.

PROPERTIES

Beech is a relatively hard, strong, heavy, uniform-textured, and close-grained hardwood with small pores, distinctive growth rings, and many prominent rays. It is a common species in the Midwestern and Southern States, but the best commercial stands are located chiefly in the beech-birch-maple forests of New England, New York, and Pennsylvania.

Appearance

The heartwood of beech is usually not too clearly differentiated from the sapwood. The heartwood is reddish or grayish in color. This difference in color is recognized in the trade by the names "red beech" and "white beech". The sapwood ranges from white to a pale flesh color.

Plain-sawed beech has nothing distinctive in its grain figure. The annual rings are rather inconspicuous in longitudinal surfaces. The pores are seldom visible, but larger rays show up as short darker dashes.

But quarter-sawing produces a much more distinctive and attractive grain pattern. The medullary rays than appear as dark conspicuous flakes, forming a grain figure much like that of sycamore. This decorative effect has been used more in European countries than in the United States. It seems rather significant that many of the popular European furniture imports, such as Danish Modern, have been made almost exclusively of beech.

Physical Properties

Beech has the unique property of wearing slick from friction created by moving contact with other wood. This makes it the most popular wood for drawer construction, drawer bearers, furniture slides, and frame parts that support other moving parts. This wearing-slick property is hardly a new discovery, as the old wood-block hand planes were invariably made of beech. This same property is also utilized in the construction of woodworking accessories for guides, fences, pressure bars, and other sliding jig and fixture components.

With all of its potential uses for interior and exterior furniture parts, beech works up to very good advantage with minimum waste in standard lumber grades. A furniture concern that uses much beech in the manufacture of its products has found it necessary to add only 20 percent to a standard allowance of ½-inch in width and 1 to 2 inches in length on all cutting bills. This compares very favorably with the allowance used for competitive species such as birch and maple.

Heavy woods are generally stronger than lighter woods --and beech is one of the heavier hardwoods. It is fairly uniform in density. On the average it weighs about 45 pounds per cubic foot at 12 percent moisture content and has a specific gravity of about 0.57.

Although beech offers considerable resistance to splitting, because of its hardness it is subject to splitting by nails and screws. On the other hand, beech surpasses most hardwoods in nail-holding and screw-holding power. Furniture manufacturers have learned that intelligent use of lead holes for nails and screws effectively overcomes the splitting tendency.

Research on technical and working properties of beech shows that this wood is well suited for furniture manufacturing requirements and is equal to or even superior to other native hardwoods used in the Northeast, except possibly in shrinkage and stability. With proper control, all of these properties are generally satisfactory for most furniture requirements.

DRYING BEECH

Beech does have a tendency to surface-check and thus had a reputation of being a difficult wood to dry. It is somewhat difficult to air-dry without defects and requires adequate protection and prevention of too-rapid drying of the lumber surface. The tendency to develop checks is especially prevalent in squares and short dimension or cut stock.

To counteract this tendency, one must protect piles of beech lumber from rain, snow, sun, and wind as much as possible. Also, stacking must be done in a way that will permit the drying rate to be adjusted by controlling the air circulation. End-coating is also recommended to prevent end-checking.

Best results are reported when beech, practically green from the saw, is kiln-dried in a modern forced-circulation dry kiln, with good automatic control of temperature

and relative humidity. Beech does not react favorably to speed-up drying schedules or uncontrolled drying conditions; but with schedules adapted to the initial moisture content and thickness of the lumber, type and condition of the dry kiln, and end-use requirements for the lumber, it can be dried with minimum degrade. At the end of the kiln run it is necessary to equalize and condition the lumber to relieve internal stresses and equalize the moisture gradient.

Proper cooling and storage of the kiln-dried lumber is equally important. Doing this in an area that affords control of temperature, relative humidity, and air movement can result in substantial dividends in the form of good lumber. Control of moisture content of work-in-process has also proved to be a most efficient equalizer.

Beech lumber has an average moisture-content range of about 60 percent green, 20 to 25 percent shipping-dry, and 6 to 8 percent kiln-dry. Maximum shrinkage in drying from green to oven-dry is estimated to be from 15 to 17 percent on a volumetric basis. Average shrinkage percentages in drying from green approximate:

		Shrinkage values		
Condition	*Moisture content (percent)*	*Radial (percent)*	*Tangential* (percent)	*Longitudinal* (percent)
Air-dry	12.6	3.0	8.2	0.12
Kiln-dry	6.6	4.5	10.6	.22
Oven-dry	.0	5.6	12.3	.36

BENDING BEECH

Beech is highly adaptable to steam-bending and is generally favored in furniture manufacture as a bending wood. It is easily conditioned for bending by steaming or boiling and gives satisfactory results in both hand- and machine-bending when proper restraining end pressure is provided. Bending tests conducted at the Forest Products Laboratory, Yale University, and other research agencies have given beech an excellent rating. In this it is surpassed only slightly by white oak.

Best results were reported when stock of 12 to 15 percent moisture content was used for mild bends, or 20 to 25 percent for more severe bends produced by hand- or machine-bending. Beech bentwood requires carefully controlled drying to prevent degrade, but this is also essential for satisfactory results with any bending wood.

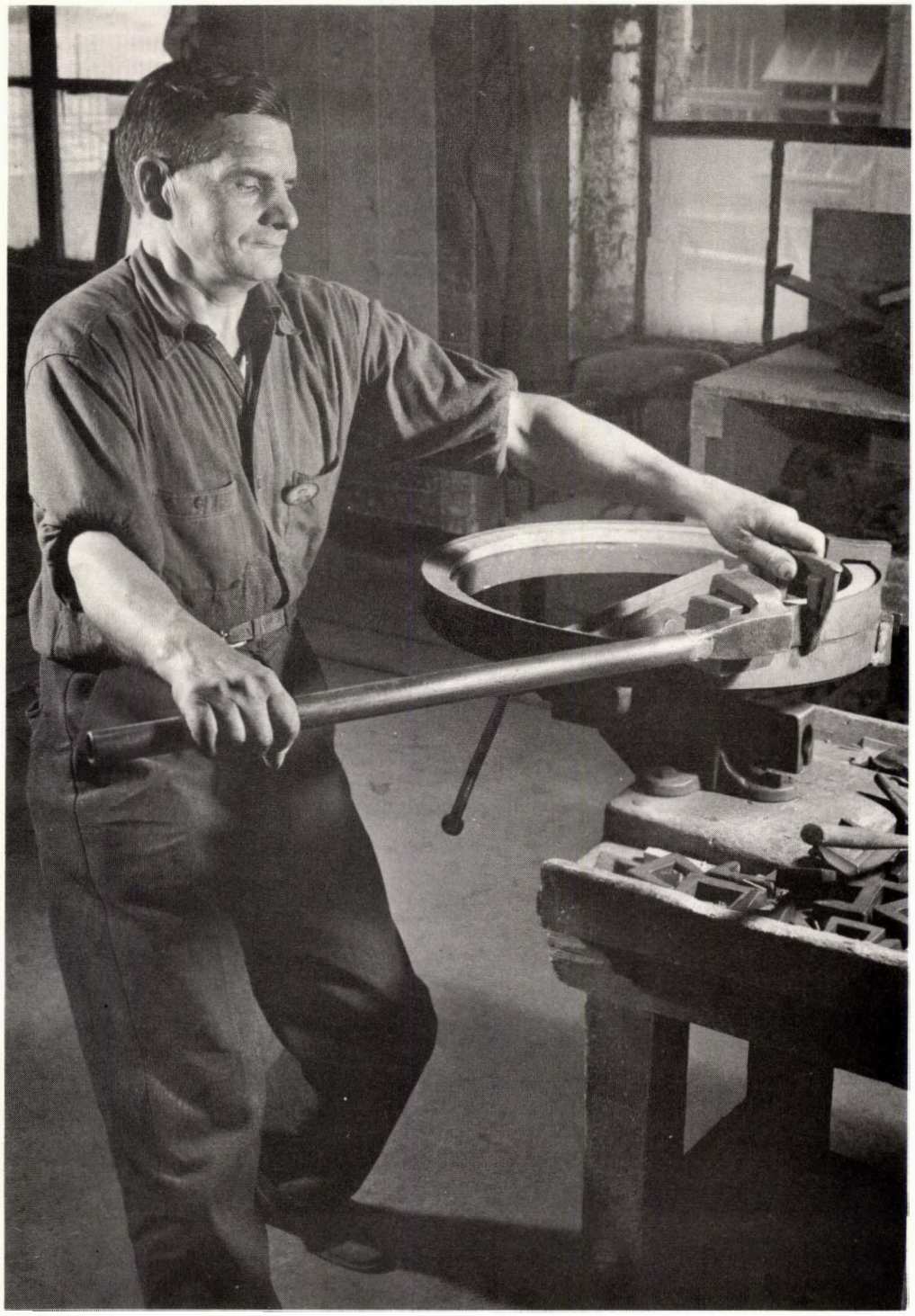

Figure 4.--*Bending a full-circle seat rim of beech. Beech is still favored for bentwood parts.*

Beech is much used for curved furniture parts such as serpentine drawer fronts. However, its greatest use as bentwood is for chair parts. Top bows, combs or backs, and arms of Colonial-type Windsor chairs are usually made of beech. Beech is also used for full-bent arm rails of Windsor arm chairs and backs and arm rails of captain chairs. Ladder-back and other full-post chairs have their backs, slats, and back posts bent of beech. Some industrial and restaurant seating pieces feature full-bent one-piece back parts, seat rims, frame reinforcements, and leg braces. Continuous backs, arms, and legs of modern chairs of popular Scandanavian design are also formed with beech bentwood.

GLUING BEECH

Experience in furniture plants indicates that gluing properties of beech are very good under controlled gluing conditions. The wood does not present any greater gluing problems than birch, maple, or other native hardwoods.

Any of the standard wood adhesives may be used on beech with satisfactory results. Evidence of the joint strength possible was found in tests made of animal glue joints made in assembly gluing operations at various furniture plants. These tests consistently showed a minimum shear strength of 2,800 p.s.i. Some tests made with synthetic resin adhesives ran as high as 3,400 p.s.i.

MACHINING

Although better adapted to machine operations than working with hand tools, because of its hardness, beech presents no serious problems in working. Many machining difficulties previously experienced when working beech have been eliminated by the use of keen-edged tools, improved machines, and better knowledge of the proper cutting angles, cutting speeds, and feed speeds.

Trouble has been reported at the saws, but it has been found that selection of the right saw and fitting it up properly for the specific job at hand can avoid any serious trouble. Carbide-tipped saws have solved many cutting and ripping problems. Cut-off saws with relatively coarse teeth and plenty of set now provide good results in the rough cutting operations. Use of bandsaw blades with the proper number of teeth and proper width and the right pitch and tooth shape eliminate bandsawing problems. High-velocity bandsaws have effectively relieved the problem of excessive strain on the bandsaw.

Figure 5.--*In this platform rocker, beech is used for the rocker bearing blocks, corner blocks, and dowels.*

Keen-edged cutters and adequate pressure are required for machining beech at the jointer, moulder, or planer. When proper cutting angles, spindle-speeds, feed-speeds, and knife-finish are used, beech is often dressed sufficiently smooth to eliminate the need for sanding and has been so used for some furniture parts.

For general surfacing operations, cutting angles of 10 to 20 degrees and a surface finish ranging from 12 to 14 knife-cuts-per-inch have produced satisfactory results. Best results are obtained when a good back-bevel is carried on the knives. The back bevel recommended ranges from about 10 degrees for green or wet wood to 30 degrees for kiln-dry stock (6 to 8 percent moisture content).

Beech shapes well at most cutting speeds but cuts smoother at higher spindle speeds (up to 7,200 r.p.m.). Cutting angles generally used for shaping range from 15 to 30 degrees, with best results obtained in the lower range for kiln-dry stock.

Most furniture plants report that beech bores well and smoothly, with little tendency for the bit to lead. Best results are obtained when bits used have strong, rather stubby cutting lips and brad points.

Beech mortises well at all types of mortising machines. Best results are obtained with the hollow chisel mortiser.

TURNING

As a turning wood, beech is surpassed only by white birch among the hardwoods native to the Northeast. It shows a high freedom from breakage, it has good ability to hold detail, and it cuts smoothly regardless of the type of lathe used. Beech turns best at the backknife lathe at a moisture content of 15 to 18 percent. Other types of turning lathes produce satisfactory turnings at a moisture content of 10 to 12 percent.

Beech is preferred for slender furniture turnings because of its distinctive combination of stiffness, strength, and hardness--often called "spine"--which makes it especially suitable for slim dimension turnings with high strength requirements, such as spindles, pillars, standards, and stretchers. This property also makes beech good for dowels.

SANDING

Sanding brings out a fine finish on beech. More pressure is required than for some other hardwoods, due to the natural hardness of beech. Beech does not scratch with 3/0 grit, but should not be polished with a grit finer than 4/0. Finishing troubles reported with beech have been traced to sanding with too fine a grit, which glazes the surface and prevents good stain penetration and proper adhesion of the finish coats.

Best results are obtained at drum- and belt-sanding machines with an average cutting speed of about 4,000 feet per minute. An open-coat garnet abrasive is generally recommended for sanding beech under 3,500 feet per minute and a full-coated aluminum oxide for higher speeds. Some of the new resin-treated garnets are now being used successfully at the higher speeds.

In general sanding operations, a 1 or 1/2 grit is usually used for rough sanding and 3/0 or 4/0 for smoothing and polishing. Dovetails of beech drawers are sanded with 1-1/2 grit to remove glue squeeze-out but are smoothed and polished with 1/2 or 0 grit. The butt grain of the dovetail is usually sanded with 1/2 grit to prevent burning. Multiple-drum endless bed sanders used for flat sanding usually carry a grit sequence on the drums of 1, 1/2, and 3/0 and operate at a cutting speed of about 4,000 feet per minute.

Best results in edge-sanding beech are usually obtained when 1/2 grit is used for rough sanding and 2/0 for finish sanding. Beech turnings are sanded smooth at the automatic turning sander with a grit sequence of 1/2, 0, 2/0 and 4/0.

FINISHING

Beech takes practically any furniture finish, as evidenced by its successful masquerade as birch, cherry, and maple in various commercial lines of wood furniture. It finishes equally well with lacquer, varnish, or synthetic finishing materials. Beech provides an excellent enamel base and when treated with a light primer coat, produces a fine simulated bleached or pickled finish.

Beech is seldom offered to the furniture trade in its natural form. However, a natural finish, such as that produced with an alkyd-urea low-baking synthetic varnish on woodenware, would seem to offer attractive possibilities. This is a natural maple-style finish that has proved to be most attractive, durable, and economical for woodenware manufacturers.

In bentwood form, beech is best stained with a pigment stain, since in such products penetrating dye stains seldom give a good uniform base color.

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SUMMARY

Furniture components vary in strength and other mechanical requirements according to their basic functions and location in the furniture construction. Working properties of a furniture wood are also very important. In closing it might be interesting to compare the ratings of beech, yellow birch, sugar maple, and black cherry as they were presented in a confidential report prepared to evaluate their relative properties for use in furniture:

	Beech	Yellow birch	Sugar maple	Black cherry
Specific Gravity (15% moisture content)	(0.705) 70	(0.706) 70	(0.778) 70	(0.577) 90
Grain and texture	80	90	90	100
Hardness	80	70	80	70
Stiffness	90	80	80	80
Strength	80	70	90	80
Stability	60	70	80	80
Shrinkage	60	70	80	80
Shock resistance	80	90	80	80
Steam bending	90	80	70	50
Nailing and screwing	70	70	70	80
Nail and screw holding	80	80	90	60
Gluing	70	80	80	80
Sawing	80	80	80	90
Planing, moulding, jointing	80	80	80	90
Shaping	80	80	90	90
Boring	80	80	80	80
Turning	90	90	80	70
Mortising	90	80	90	80
Dovetailing	80	80	80	80
Carving	80	80	80	90
Sanding	90	80	80	90
Finishing	90	80	80	90

Merit-factor summaries can be used to indicate the relative properties of the respective woods. The higher the merit factor, the better the all-around properties of the wood for furniture manufacture. A very slight difference is

shown by a merit-factor comparison: beech has a total merit factor of 1750, yellow birch 1730, sugar maple and black cherry 1780.

The logical conclusion to be drawn is that beech is an ideal furniture wood that has physical and working properties of sufficient merit to warrant presentation to the trade under its own identity rather than being forced to masquerade as woods it supplements and replaces for reasons of lower cost. If the advantages of furniture parts now being made of beech were fully appreciated and properly publicized, a "use-beech-for-furniture" movement would soon be under way.

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(CONTINUED FROM INSIDE OF FRONT COVER)

* Chemistry and chemical utilization of beech.
* Silvicultural characteristics of beech.
* Availability and supply of beech.
  Present markets and uses for beech.
* Logging beech and specifications for products.
* Seasoning beech lumber.
* Storage of beech logs and bolts.
* Machining of beech.
* Milling of beech.
* Gluing techniques for beech.
* Steam-bending of beech.
  Preservative treatment of beech.
* Beech for flooring.
* Beech for furniture.
* Beech for turned products and novelties.
* Beech for veneer and plywood.
* Beech for fuel and charcoal.
* Beech for crossties.
* Beech for containers.
* Pulping and defiberization of beech.
* Rough construction on the farm with beech.

The Northeastern Station acknowledges gratefully the effort being devoted to these problems by the many agencies and individuals who are cooperating in this project. Among the leaders in it are David B. Cook, New York State Conservation Department; Claude Bell, U.S. Forest Products Laboratory; A. H. Bishop, State University of New York, College of Forestry; and Fred Wangaard, Yale University School of Forestry. These men, along with Fred C. Simmons and C. R. Lockard of the Northeastern Station, comprise the working committee that is directing and coordinating the project.

The information gathered in this widespread cooperative project should be of great use to the wood-using industries of the regions where the wood of American beech is available.

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*Reports published.